Republic of Yemen

Scientific Research

Faculty of Engineering and

Information Technology

ULTTRASONIC SCALER DEVICE

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SABRY A-ALMANNAN AL-ABSI

A graduation project report submitted to the Department of BioMedical Engineering in partial fulfillment of the requirements of a bachelor's degree in 2023/2024.

Supervised by

Assoc.prof. Moshtaq Al-Azazy

Yemen, Sana'a

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Supervisor Certification

I certify that the preparation of this project entitled ULTTRASONIC SCALER DEVICE

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was mad under my supervision at Biomedical Engineering department in partial fulfillment of the requirements of bachelor degree in Engineering.

Supervisor Name: Moshtaq Al-Azazy

Signature

Date

Dedication

This project is dedicated to our parents who have never failed to give us financial and moral support, for giving all our needs during the time we developed our project.

This project is dedicated to our teachers who helped us to reach where we are now.

We also dedicated this project to our brothers and friends who usually support us.

Finally, to us.

Declaration

We are, **OMAR AL-REFAI,MOSTAFA AL-JUNAID,MOATAZ ANAAM,AMJAD A-ALRA'UF AL-JUNAID,** HANI AL-SHAIPANY,NIZAR ALSHAIPANY,SABRY AL-ABSI ,declare that this graduation project titled "**Scaler Device**" submitted to fulfillment of the requirements for the degree of Bachelor, in **Biomedical Engineering**, Emarets International University, is wholly our own work unless otherwise referenced or acknowledged. This document has not been submitted for qualifications at any other academic institution.

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- The Head of Biomedical Engineering Department Dr.Mohammed Alolofy , and our teachers

Abstract

The ultrasonic scalers are today becoming the most chosen form of dental polishing and cleaning. With the various researchers and lab tests done on them, it is steered clear of any side effects or invasive methodologies that might harm the patient in any manner. It works both on the soft and hard oral tissues have become the most widely used cleaning instruments among dental practitioners. Ultrasonic scalers use its vibrating power to eradicate different forms of dental plague and foreign components from the teeth. Through various on-field experiments and lab tests, it was made sure that these ultrasonic scalers work much better than any other primitive method for the same task. And that's the major reason why it is so much in demand, ultrasonic scaling has become widely used for professional tooth cleaning. This project aims to design and manufacture a modern and integrated Dental Scaler device equipped with a screen that monitors voltage, current, and frequency, ensuring high and accurate performance in dental cleaning and tartar removal procedures. The device also includes a water container and a water valve for more effective cleaning. The scaler is external for ease of use and cleaning. The device uses a PIC microcontroller to control its operations.

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Chapter 1
Introduction

1.1 Overview

Ultrasonic scalers are advanced dental instruments designed to efficiently remove calculus and plaque from tooth surfaces. These devices employ high-frequency vibrations transmitted through a slender tip to disrupt and fracture calculus deposits. The generated vibrations, combined with a water coolant, create cavitation and acoustic microstreaming, facilitating calculus removal. Key components of an ultrasonic scaler include the handpiece, transducer, tip, and water delivery system. The handpiece houses the electronic circuitry and motor, while the transducer converts electrical energy into mechanical vibrations. The tip, the working end, is interchangeable to accommodate various clinical situations. Water coolant serves to cool the tip, remove debris, and enhance visibility during the procedure.

Understanding the design, components, and operating principles of ultrasonic scalers is essential for dental professionals to optimize their use in periodontal therapy and achieve optimal clinical outcomes.

1.2 Problem statement

Periodontal disease remains a prevalent oral health issue characterized by the accumulation of calculus and plaque, leading to gingival inflammation and progressive bone loss. Traditional hand instrumentation for calculus removal is time-consuming, labor-intensive, and often results in patient discomfort. The increasing prevalence of periodontal disease coupled with the limitations of traditional methods underscores the need for efficient and effective treatment modalities. Ultrasonic scalers, with their potential to expedite calculus

removal, reduce patient discomfort, and improve clinical outcomes, have emerged as a promising alternative.raditional dental scalers, however, often lack integrated systems for real-time monitoring of operational parameters such as voltage, current, and frequency. This limitation can lead to inefficiencies in treatment, potential safety hazards, and a lack of precise control over the scaling process.

Lack of Real-Time Monitoring: Without real-time monitoring, it is challenging for dentists to ensure that the scaler operates within optimal parameters. This can result in inconsistent performance and, in some cases, device malfunction, which affects the quality of dental care.

Inefficient Cleaning Processes:Many scalers do not include features that enhance cleaning effectiveness, such as integrated water systems. This can lead to less efficient removal of dental calculus and tartar.

Device Usability and Safety Concerns: Existing devices often lack user-friendly interfaces and safety features, which can affect the ease of use and overall safety of dental procedures.

Need for Integration and Innovation There is a need for a modern dental scaler that integrates real-time monitoring of electrical parameters and includes features such as water control to improve cleaning effectiveness and device safety.

. However, there is a paucity of projects dose not applying the optimal parameters, clinical efficacy, and long-term effects of these devices. This project aims to address these challenges, this project proposes the design and development of an advanced Dental Scaler device equipped with a screen for real-time monitoring of voltage, current, and frequency. The device will also include an integrated water container and valve to enhance cleaning

efficiency. By using a PIC microcontroller to control and monitor these features, the proposed scaler aims to improve both the accuracy and safety of dental scaling procedures, providing a more effective and user-friendly tool for dental professionals.

1.3 Project objective

The main objective of this project is to design scaler device to treat several diseases and monitor parameters status at the same time, which has the following characteristics:

- Treat Periodontal disease, accumulation of calculus and plaque.
- Provide integrated systems for real-time monitoring of operational parameters such as voltage, current, and frequency
- Portable.
- low cost.

We achieve this objective by fulfilment the following subobjectives:

- Apply design of the device.
- Implement the project circuit.

1.4 Research Organization

In addition to this chapter, this research is organized as follows:

- Chapter (2) Includes medical and engineering of ultrasonic scaler.
- Chapter (3) Includes block diagram of the project with explanation and flow chart.
- Chapter (4) Includes and implementation of the project (hardware).
- Chapter (5) Includes results and discussion.
- Chapter (6) Includes conclusion and recommendation.

Chapter 2
Medical and Engineering Background

2.1 Medical Background

History of Ultrasonic Scaler

The introduction of dental ultrasonic scalers dates to the mid-20th century when technological innovations started revolutionizing dental practices. An American periodontist introduced the first ultrasonic device in the 1950s, pioneering the use of ultrasonic vibrations for calculus removal. Since then, advancements in materials, technology, and design have enhanced these devices, making them a vital asset in dental offices worldwide.

Anatomy and Morphology Review

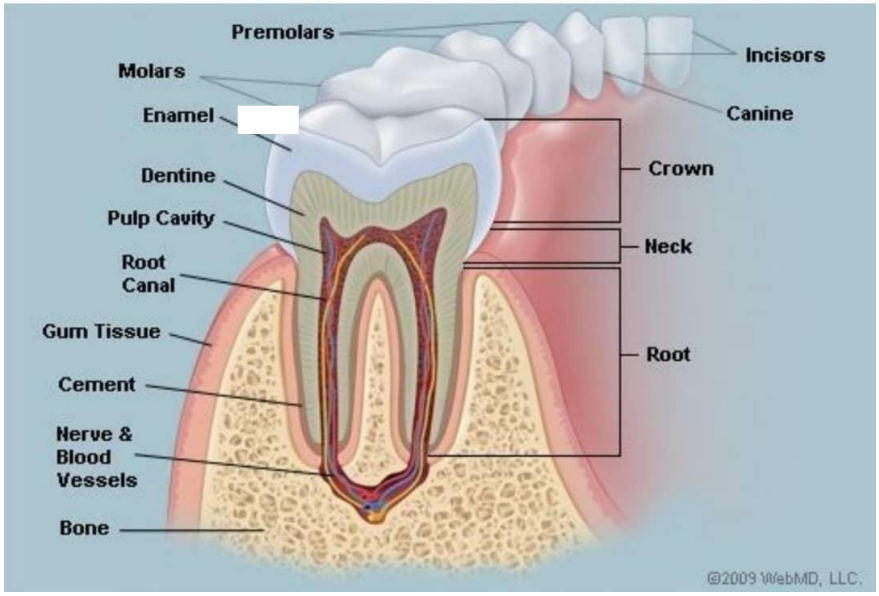


Figure 2, 1 Teeth

Teeth :

1. Enamel- Covers the entire anatomic crown, hardest tissue found in the body.

2. Dentin – Makes us the bulk of the tooth. Made up of tiny tubules that contain fiber known as “Tomes Fibers”. Dentin is formed through the life of the tooth and includes both primary and secondary dentin.

3. Cementum– Hard tissue that covers the entire tooth root Primary function is to attached the periodontal fibers to the root of the tooth and has the ability to regenerate.

4. Pulp - the "living" tissue of the tooth. It consists of connective tissue, blood vessels and nerves. The various functions of the pulp include: formation, nutrition, sensory and defensive.

Supportive Tissues: (AKA Periodontium)

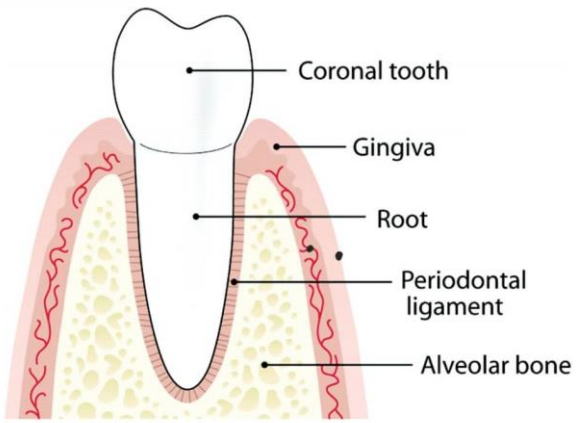


Figure 2, 2 Supportive Tissues

1. Periodontal Ligament – Surrounds the tooth root and attaches the tooth to the wall of the tooth socket. Additional functions include Nutritive and Formative.

2. Alveolar Bone – Forms tooth socket and supports the tooth.

a. Lamina Dura – Hard dense bone that lines the tooth socket.

b. Cortical Plate – Hard, dense bone covering the outer surface of bone.

3. Gingiva – Soft tissue covering the bone within the oral cavity and consists of 4 different types.

a. Free Gingiva – surrounds the cervical area of each tooth.

b. Attached Gingiva – Directly attached to bone.

c. Gingival papilla – Cone shaped elevation found between each tooth and fills the embrasure.

d. Gingival Sulcus – The space between the tooth and the free gingival. Normal sulcus depth ranges from 1 – 3 mm.

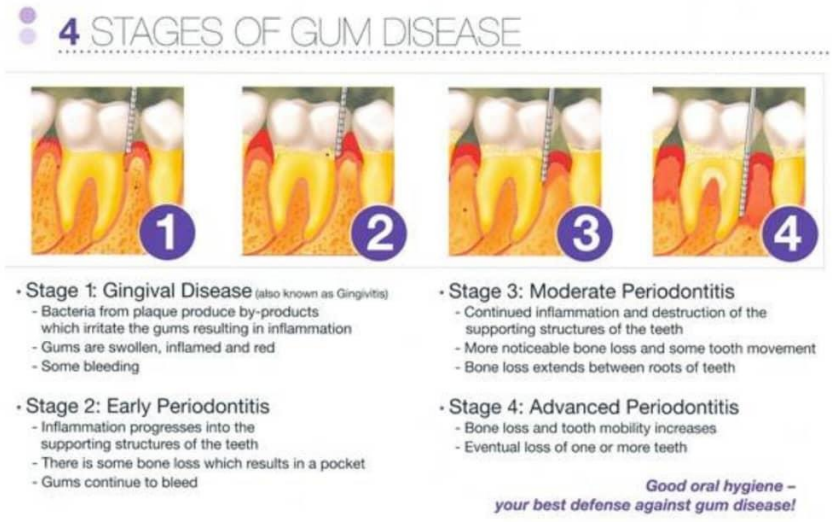


Figure 2, 3 Stages of Gum Disease

What to look for – Normal:

* Pale, pinkish color

* Stipples (orange peel effect) appearance

* Contoured “scalloped” appearance

* Firm, resilient when touched with an instrument

* No bleeding

* Sulcus depth 1 – 3 mm

Abnormal:

* Inflamed, red, bluish-red color

* Recession or enlarged, swollen

* Loss of stippling

* Shiny or smooth appearance

* Spongy, bleeds easily

* Increased sulcus depth 4+mm

Anatomical & Physiological Factors

Remember to always:

Review the patient's medical history and ask about illnesses. Make notations on the patient's chart regarding intraoral abnormalities such as:

* Rough, exposed areas of cementum

* Eroded areas

* Obvious carious lesions

* Improperly polished fillings

* Decalcified areas

* Mottling of enamel

Tooth Deposit such as:

* Plaque: Soft deposits found on the tooth surface consisting primarily of bacteria, and bacterial products. The primary components saliva, pellicle and cellular debris. Supragingival plaque becomes more visible as it accumulates and can range in color from gray to yellow. Things to remember about plaque:

  o It develops on tooth surfaces, restorations, appliances, and dentures.

  o It is most commonly found on the third gingival of the teeth, in cracks, defects and rough areas of overhanging margins and restorations.

  o It accumulates more on facial surfaces of the maximum molars near the parotid glands

and the lingual surfaces of the mandibular molars.

* Calculus: Hard calcium deposits on the tooth (Hardened plaque). Usually found near the gum line.

Tooth morphology and other related anomalies such as :

* Congenital Tooth Anomalies may include:

o Extra or missing cusp(s)

o Bell shaped crowns

o Peg shaped crowns

* Faulty contacts

* Rough/abraded occlusal and/or incisal surfaces

* Improperly contoured restorations

* Dental appliances (orthodontic, fixed or removable partial dentures)

* Malocclusions (crowded, rotated, extruded, tilted, and incompletely erupted teeth)

* Gingiva – recession or hyperplasia

* Tongue, lips, cheeks may have – congenital malformation, loss of muscle tone or restrictions in elasticity.

Classifications of Tooth Stains :

Here are 2 basic types of tooth stains:

1. Exogenous - originally forms on the outside surface of the tooth. It has the ability to move into the tooth becoming a permanent stain. These stains can be removed with polishing.

2. Endogenous – originally forms inside the tooth. It always remains internal, never moving to the outside surface of the tooth. These stains that cannot be removed with polishing.

A secondary stain category refers to where the stain originates:

1. Extrinsic – occurs on the tooth surface and is caused by outside factors. Is always considered exogenous

2. Intrinsic – occur from within the tooth to cause staining and may be considered either exogenous or endogenous.

The following is a list of different stains with their classifications.

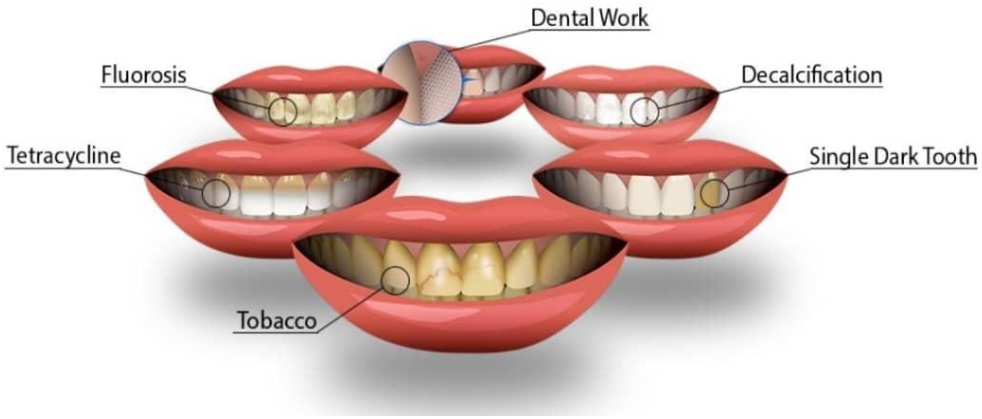


Figure 2, 4 Different Stains

o Yellow and Brown Stains – Exogenous & Extrinsic, this type of stain is associated primarily with plaque formation and poor oral hygiene. It occurs in all ages. Commonly found on the buccal surfaces of maxillary molars and on the lingual surface of mandibular incisors.

o Green Stain – Exogenous & Extrinsic, color may vary from light to dark green or even have a yellowish-green appearance.

Commonly seen on children's teeth on the facial surfaces of the maxillary anterior teeth near the cervical area.

o Tobacco Stain – Exogenous & Extrinsic – but can develop into intrinsic if not removed. A result of pigments of coal tar combustion in cigarettes or rum chewing tobacco that penetrates the pits and fissures of the enamel and dentin. Color ranges from light brown to black.

o Black Line Stain – Exogenous & Extrinsic, manifests as a thin black to dark brown line that is slightly above the gingiva and follows the contour of the gingival margins. It is common in women even when good oral hygiene is practiced. It forms on both the facial and lingual surfaces and tends to return after removal.

o Orange Stain – Exogenous & Extrinsic, occurs due to over exposure to chlorhexidine. It is frequently found in chewing gum and types of mouthwash. Color ranges from yellow to light brown and can be found on the tongue, restorations, in plaque near the cervical and interproximal surfaces of the teeth.

o Tetracycline Stain – Endogenous & Intrinsic, results from large concentrations of tetracycline antibiotics being taken during the development of the tooth. Color may range from light green to a yellow to a dark gray or brown appearance.

o Dental Fluorosis – Endogenous & Intrinsic, High levels of fluoride in the system during the development of the tooth will cause a discoloration ranging from white to yellowish brown or grey-brown. The outer surface of the tooth may also be affected by being pitted or rough. These conditions may give the tooth a mottled appearance.

o Pulp-less Teeth (non-vital teeth) – Endogenous & Intrinsic, occurs when the pulp has been damaged or removed. The color may vary from light yellow to black, green or magnets. This is caused by blood and pulp tissues moving into the dentin.

o Metallic Stain – Endogenous & Intrinsic, or Extrinsic in origin. Staining may occur due to inhaled metal and metallic salts, if taken orally in medications, or as part of a restoration.

The metals adhere to the pellicle and soft debris on the tooth surface and penetrate the surface becoming a part of the tooth structure.

2.2 Engineering Background

Ultrasonic Scalers

Introduction to Ultrasonic Technology Ultrasonic technology, the foundation of ultrasonic scalers, involves the generation and utilization of sound waves with frequencies beyond the audible range of human hearing (typically above 20 kHz). This technology has found applications in various fields, including medical imaging, material processing, and cleaning. In dentistry, it has been adapted for periodontal therapy in the form of ultrasonic scalers.

Basic Principles of Ultrasonic Scalers

Ultrasonic scalers function by converting electrical energy into high-frequency mechanical vibrations. This process typically involves a piezoelectric or magnetostrictive transducer.

* Piezoelectric Transducer: Relies on the piezoelectric effect, where certain materials generate an electric charge when subjected to mechanical stress or vice versa. In ultrasonic scalers, an alternating electric current applied to the transducer causes it to vibrate at ultrasonic frequencies.

* Magnetostrictive Transducer: Operates on the principle of magnetostriction, where a ferromagnetic material changes its shape in response to a magnetic field. By applying an alternating current to a coil surrounding the material, it can be made to vibrate at ultrasonic frequencies.

These vibrations are then transmitted through a slender metal tip to the tooth surface. The rapid oscillation of the tip in combination with a water coolant creates cavitation and acoustic microstreaming. Cavitation involves the formation and collapse of tiny bubbles in the liquid, generating shock waves that dislodge calculus. Acoustic microstreaming refers to the unidirectional fluid flow created by the vibrating tip, which aids in calculus removal and debris clearance.

Design Considerations and Challenges

Designing an effective ultrasonic scaler requires careful consideration of several factors:

* Power Output: The intensity of the ultrasonic vibrations must be sufficient to remove calculus without damaging tooth structure.

* Frequency: The optimal frequency for calculus removal and patient comfort needs to be determined.

* Tip Design: Tip shape, size, and material influence the efficiency and safety of the scaling process.

* Water Delivery: Adequate water flow is crucial for cooling the tip, removing debris, and enhancing visibility.

* Ergonomics: The handpiece design should prioritize operator comfort and reduce the risk of musculoskeletal disorders.

Challenges in ultrasonic scaler design include minimizing noise levels, preventing overheating of the tip, and ensuring biocompatibility of materials. Additionally, balancing the need for effective calculus removal with the preservation of tooth structure and gingival tissues is a critical consideration.By understanding the fundamental principles of ultrasonic technology and the engineering challenges involved in scaler design, researchers and manufacturers can develop improved devices that enhance periodontal treatment outcomes.

Ultrasonic Tips and Techniques

A variety of inserts are available for use with the ultrasonic curette. Each insert is designed for a specific use.The manufacturer recommends a power level for each insert.The choice of tip depends on the type, location, and amount of tartar and stain deposits,with the smaller tips used by the dentist or hygienist being similar in design to a dental curette and can be used under the gums. The tips should be blunt so as not to damage the tooth surface and root. Below is a list of the different tips and their uses.Beaver Tail Ultrasonic Tip – Used on thelingual and facial posterior surfaces to remove very heavy deposits above the gums.Use light pressure with a sweeping motion to remove stains and overlapping strokes to remove tartar. Avoid using the sides or face of this insert. Use a high power level when using this insert. Chisel Ultrasonic Tip – Used to remove tartar above the gums on the front teeth. Place the tip on the proximal tooth surface and use a horizontal stroke to remove tartar. Set the power level to high when using this insert. Universal Ultrasonic Tip – The most commonly used tip for supra- and subgingival tartar deposits in all areas.The universal tip is ideally suited for finishing after heavier scaling procedures. Use the sides of the insert with only light pressure, push or pull strokes. Set the retainer level to high when using this insert.Ultrasonic End of Periodontal Probe – Used for subgingival tartar removal.

Used by the dentist for dental hygienist with a horizontal or vertical stroke. Use medium power level when using this insert.

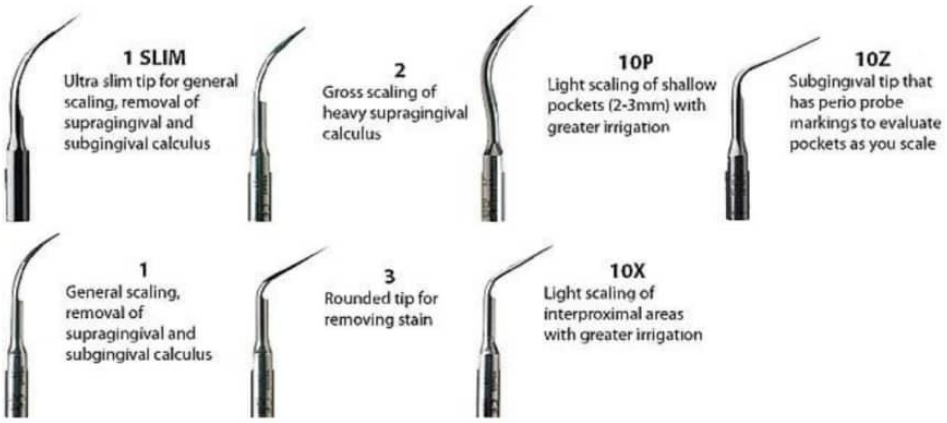
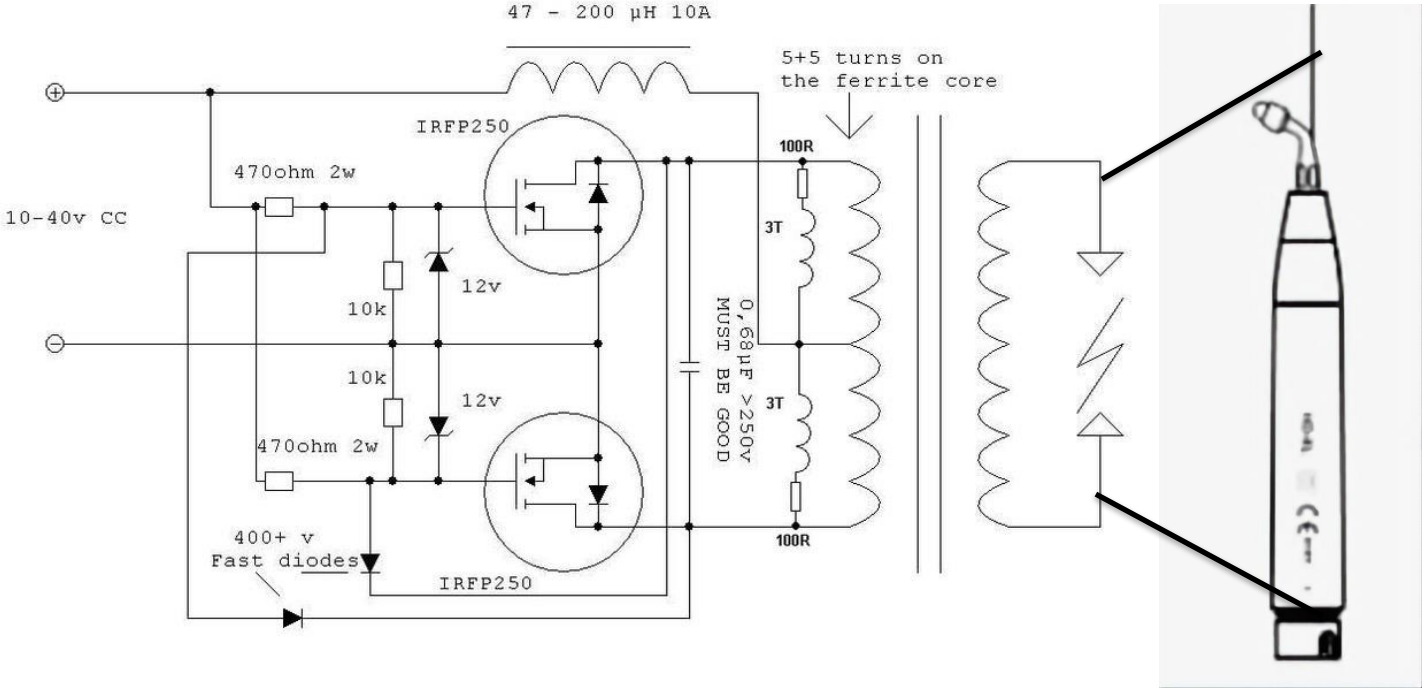


Figure 2, 5 Typs of Inserts

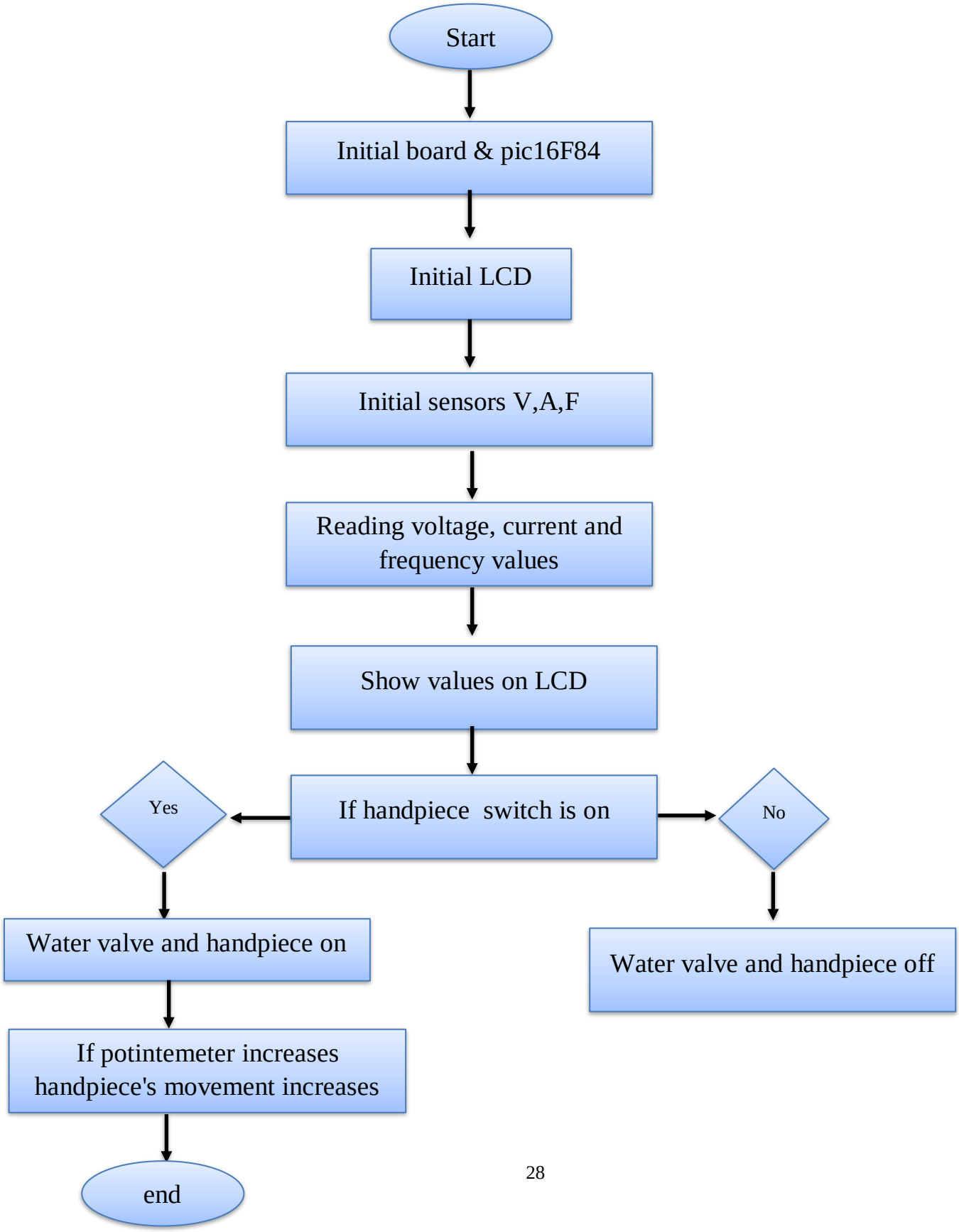
Chapter 3

Design of the Ultrasonic Scalar Device

2.3 Block Diagram



2.4 Flow chart



2.5 Components of the Project

Display Screen

LCD 16*2 displays the voltage, current, and frequency used in the device.

*Figure 3, 1 LCD 16*02*

Water Container

A 310ml plastic container , Storing water needed for cleaning process

Water Valve

3mm valve , Controlling the flow of water from the water tank to the header.

Scaler Tip

Produces high frequencies needed to remove tartar from teeth.

PIC Microcontroller

Pic16f84a, Processing and managing all operations in the device including display control and control of other components. Also frequency output.

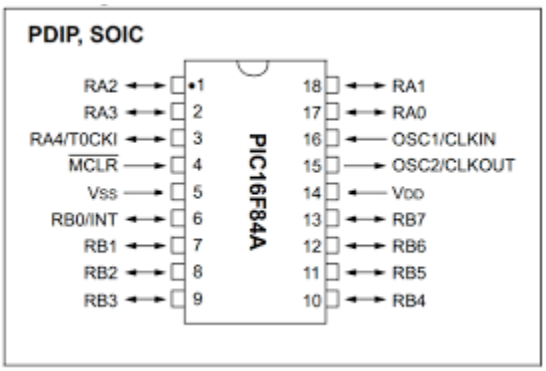


Figure 3, 2 Pic16F84A

Voltage Sensor

Measure the voltage used in the circuit to be displayed on the screen.

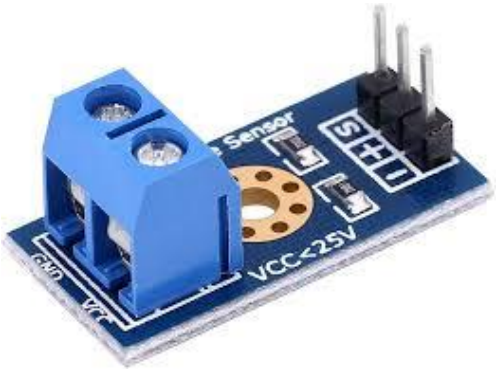


Figure 1Voltage Sensor

- **Features and Benefits**
  - High accuracy, 24/7 monitoring, cost saving.
  - Range: Ability to measure a wide range of voltage values (AC or DC).
  - Response time: Quick detection of voltage changes.
  - Improved equipment performance.
  - Isolation: Protection from electrical interference.

Frequency Sensor

Measure the frequency used in the header to be displayed on the screen.

Figure 3, 3 Frequency Sensor

- **Features and Benefits**
  - Detecting objects, gauging temperature, monitoring pressure, and identifying motion.
  - Accuracy: Precise measurement of frequency.
  - Range: Ability to measure a wide range of frequencies.
  - Response time: Quick detection of frequency changes.
  - Improved equipment performance.

Current Sensor

Measure the current used in the circuit to be displayed on the screen.

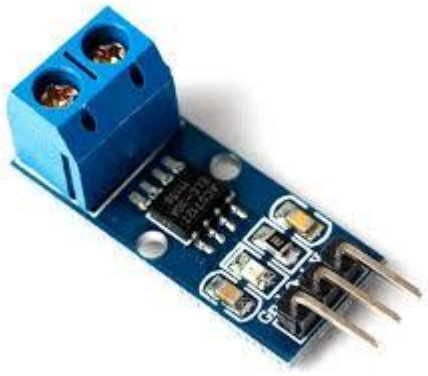


Figure 3, 4 Current Sensor

- **Features and Benefits**

  - low heat generation, an extended bandwidth, high resolution, and a low offset.
  - Accuracy: Precise measurement of Current.
  - Range: Ability to measure a wide range of Current.
  - Response time: Quick detection of Currentchanges.
  - Improved equipment performance.

Flyback Driver

- Description: The ZVS flyback driver uses resonant zero voltage switching (also known as ZVS) to operate the flyback transformer. This means that the MOSFET is designed to switch (on or off) when the voltage across it becomes zero. Since the MOSFET switches when there is no voltage across it, it will generate very little heat, and the only source of heat is the internal resistance of the MOSFET. Unlike simple flyback drivers with a 555 timer, ZVS flyback drivers will allow you to operate your flyback transformer for much longer periods of time before the MOSFET overheats. If you get really good MOSFETs, it may be possible to operate your ZVS flyback driver indefinitely! (or until the circuit breaks.)

- Parts:

  * Flyback transformer

    A recoil transformer can be operated at very low voltage. When the primary winding of the transformer is excited by a sawtooth voltage, which is of low value, due to the nature of the sawtooth shape, it is rapidly energized and de-energized. As a result, the beam on the cathode ray tube flies backwards from right to left, with this particular property being obtained due to the action of the transformer.

  * 2x 470Ω 2W resistors

  * 2x 10KΩ 1/4W resistors

* 2x 12v 1/4W zener diodes

* 2x 400+ volts fast diodes UF4007

    - ultra-fast switching
    - continuous reverse voltage rating of 1000V
    - suitable for forward currents of up to 1A
    - has a reverse recovery time of 75ns
    - ideal for use in power supplies and switched voltage converter circuits.

* 1x 47uh inductor

* 1x 0.68uF 250v capacitor

* 2x IRFP250 MOSFET's

    - Repetitive avalanche rated
    - Isolated central mounting hole
    - Fast switching
    - Ease of Paralleling
    - Simple drive requirements
    - Material categorization: for definitions of compliance

* 2x 100*25*10 heatsink

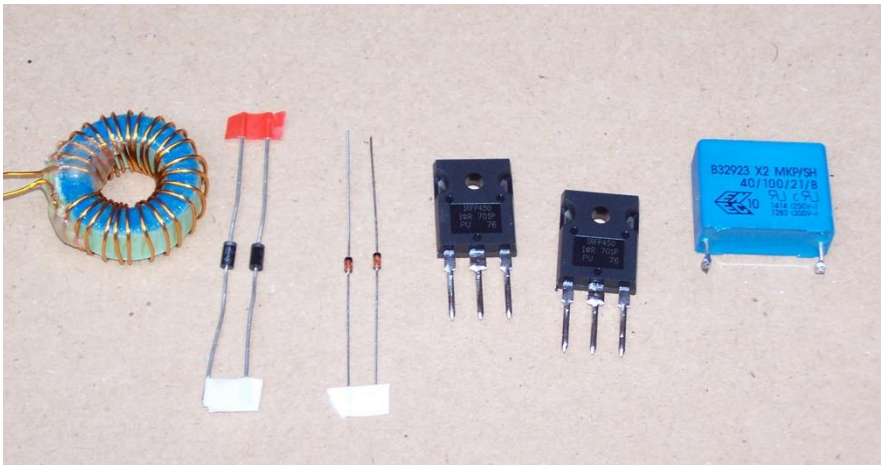


Figure 3, 5 parts of Flyback

Chapter 4

Implementation of Project

3.1 Implementation of project

Project description

It combins theoretical knowledge with practical application, the project aims to enhance the efficiency and effectiveness of calculus removal while minimizing potential damage to tooth structure. Through a comprehensive literature review, design optimization, prototyping, and rigorous testing, this study seeks to contribute to the advancement of ultrasonic scaler technology and improve dental patient care

Project Implementation Steps

* Piezoelectric Transducer: Converts electrical energy into mechanical vibrations.

* Ultrasonic Generator: Generates the high-frequency AC signal to drive the transducer.

* Handpiece: Connects the transducer to the scaler tip.

* Scaler Tip: The part that comes into contact with the teeth and transmits vibrations.

* Control Circuit: Regulates power, frequency, and other parameters.

* LCD Display: Displays voltage, current, and frequency values.

* Sensors: Measure voltage, current, and frequency.

* Water Container: Holds water for cooling and cleaning.

* Water Valve: Controls the flow of water.

* Limit switch : normally open

Connection Steps:

* Transducer to Handpiece:

  * Mounting: Securely attach the transducer to the handpiece.

  * Alignment: Ensure proper alignment for efficient vibration transmission.

* Transducer to Generator:

  * Electrical Connection: Connect the transducer leads to the generator's output.

  * Polarity: Verify correct polarity.

* Handpiece to Scaler Tip:

  * Attachment Mechanism: Use the provided mechanism to connect the tip.

  * Alignment: Ensure proper alignment for vibration transmission.

* Generator to Control Circuit:

  * Power Supply: Connect the control circuit's power supply output to the generator's input.

  * Signal Connection: Connect control signals (e.g., power, frequency) to the generator's inputs.

* Control Circuit to Sensors:

  * Connect: Connect the sensor outputs to the control circuit's inputs.

* Control Circuit to LCD:

  * Interface: Connect the LCD to the control circuit using the appropriate interface (e.g., I2C, SPI).

* Water Container to Valve:

* Connect: Connect the water container to the water valve.

* Valve to Control Circuit:

* Connect: Connect the valve's control signal to the control circuit's output.

Additional Considerations:

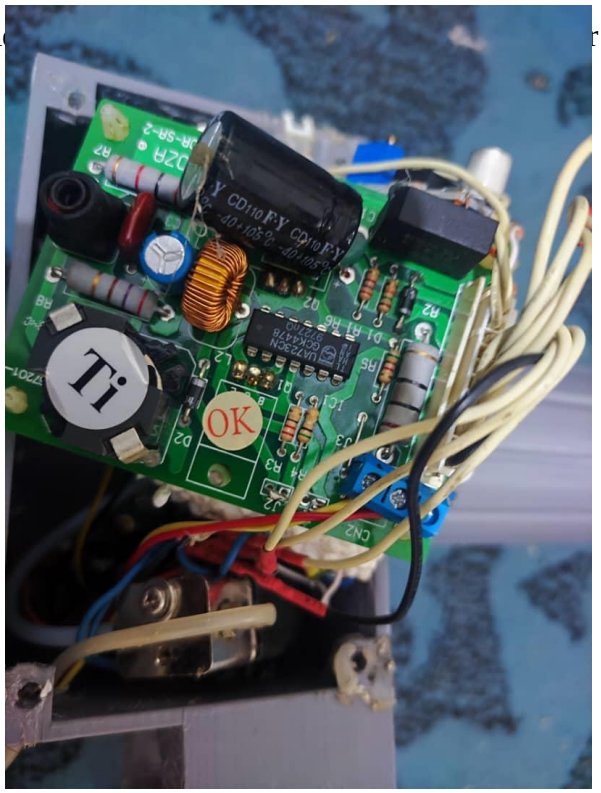
* Cabling: Use appropriate cables, ensuring good conductivity and shielding if needed.

* Power Supply: Ensure adequate power for all components.

* Testing: Test each component and the entire system after assembly.

* Software: Write software to control the control circuit, read sensor values, and display data on the LCD.

* Safety: Impl r electrical hazards.



Chapter 5

Results

4.1 Results

We created a project with the aim of providing solutions and additions that are not available in similar devices in the commercial market. We were able to control the frequencies and voltage of the device so that you can control the scaller's capacity, including the ability to control the Internet. This point contributed to adding services to our device. Through this, we set our goal to show the required results of the frequency, voltage and amperage values of the device on the LCD display screen. We were able to control multiple values and frequencies by means of a variable resistance so that the resistance changes to the desired values, including the opportunity. It also allows the addition of a sensor to the connected grip. Through this sensor, the device is concerned in the event that the grip is in the place where the approved sensor is located, and in the event that the grip is not in its place, the device is operated. This technology adds the advantage of saving energy and extending the life of the device to the devices available in the market. Our practical experience in medical clinics showed excellent and effective performance as planned, and the device works well as shown in the medical report.

Chapter 6

Conclusions & Recommendations

5.1 Conclusions

Ultrasonic scalers have become indispensable tools in modern dentistry, offering significant advantages over traditional methods. Understanding the basic principles, components, and operating mechanisms is crucial for further progress in this field. This project aims to provide an innovative and effective solution in the field of dentistry by designing a dental scaler equipped with a voltage, current, and frequency monitor and an integrated water system at a cost that is considered more economical than similar devices in the local market. The integration of the monitoring system and the water delivery system represents a major advance in ultrasonic scaler technology. By providing real-time data, enhancing cleaning efficiency, and improving patient comfort, this improved device offers many benefits to both dental professionals and patients. Future research may focus on expanding the monitoring capabilities, exploring different features that can be added, and investigating the possibility of adding additional integrated features.

5.2 Recommendations

- Advanced Monitoring Capabilities: Expand the monitoring system to include additional parameters such as tip temperature, vibration amplitude, and water flow rate. This comprehensive data can provide valuable insights into device performance and potential areas for optimization.
- Wireless Connectivity: Integrate wireless communication technology to enable remote monitoring and control of the ultrasonic scaler. This feature can facilitate data collection, device management, and potential integration with electronic health records.
- Sterilization and Disinfection: Develop effective sterilization and disinfection protocols for the entire device, including the handpiece, water delivery system, and monitoring components.

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